A GEOLOGIC SECTION ACROSS CALDWELL COUNTY, TEXAS

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A GEOLOGIC SECTION ACROSS CALDWELL COUNTY, TEXAS

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By

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PREFACE

I wish to express my gratitude to Dr. E. H. Sellards who suggested the subject of this paper. I wish also to express my appreciation for the assistance and material offered by numerous geologists and oil compnaies in Texas. Mr. McCollum of the Humble Oil and Refining Company, Mr. Dawson of the Gulf Production Company, and Mr. Brucks of the United North and South Oil Company were very kind in rendering their services and placing maps, cross sections, and well records at my disposal.

There are others who have aided me considerably, and I am very grateful for the assistance which has been accorded me.

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INTRODUCTION

Caldwell County is located in the Gulf Coastal Plain of Texas. The rocks which outcrop in this county are of Cretaceous, Tertiary, and Quaternary ages. To the west of this county, in Hays and Travis counties, the Balcones fault system forms one of the most prominent geologic features. To the east and south-east of this Balcones system and passing through Caldwell County, The Luling-Mexia fault system forms another important structural feature. Although they may differ somewhat in age, these two systems represent one general system of folding and faulting.

The principal purpose of this paper is to determine the relations, if any, that exist between the thicknesses of the various formations in Caldwell County, and these fault systems, in the hope that something further may be learned as to the age of the faulting.

STRATIGRAPHY OF CALDWELL COUNTY

In the following few pages there is presented a summary of the characteristics of the beds which are exposed at the surface and of those penetrated by the drill, in Caldwell County. In the execution of this work a number of logs of wells were studied and seven cross sections were constructed. Six of these profiles are taken at about right angles to the strike of the formations, while one of them parallels the strike. East of the Salt Flat Fault line very few wells have been drilled, and consequently but few logs have been obtained in that area. By necessity, therefore, the subsurface formations in the eastern part of the county have been dealt with but very little.

<u>Quaternary System</u>

Pleistocene-Recent Series

Some of the stream valleys of Caldwell County, in particular the San Marcos River and Plum Creek, are filled with material which is of Pleistocene and Recent age. This material often assumes the aspects of a terrace, and in some cases may possibly be correlated with the seaward facing terraces of the Coastal Plain. These beds consist largely of sandy clay, gravel, silt, and loam. They are not conformable with any of the formations which occur beneath them, and they are normally above all other beds in the geologic section. The thickness of this stream material is variable, depending upon the size and gradient of the stream. Vertebrate fossils arennot rare.[1]

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1. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River", <u>United States Geological Survey Professional Paper 126</u>, 1924, p. 120 and Pl. VIII.

Tertiary System

Pliocene (?) Series

Reynosa (Uvalde).- The thickness of the Reynosa formation is variable up to 100 feet. The upstream deposits rest uncomformably on all beds of earlier age in the county. They are not covered by later deposits. These beds are characterized by their consisting of jaspar, orthoclase granite, quartz, flint, and silicified wood (which is not indigenous). The pebbles range in diameter from one inch to six inches, and they assume any shape from angular to rounded. The Reynosa is essentially an alluvial deposit. It occurs in scattered splotches throughout the county, and it may be observed in the vicinity of McMahan, Dale, Delhi, Maxwell, and Lytton Springs. Silicified wood is the only type of fossil to be found, and this is not indigenous, having been derived from older formations through the processes of erosion.[2]

Eocene Series: Claiborne Group

Yegua.- The thickness of the Yegua formation is about 300 feet. This formation lies conformably above the Cook's Mountain formation and below the Fayette formation. It is made up of yellow and brown sand, thin and lenticular beds of lignite, and dark green and brown selenitic clays containing fossil leaves. These beds are palustrine to marine. Marine fossils, however, are uncommon. In the palustrine members the following species of plants are common:- Anemia eocenica Berry,

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2. Deussen, A., Ibid., pp. 111-112 and Pl. VIII.

Arundo pseudogoepperti Berry, Coccolobis clairbornensis Berry, Coccolobis columbianus Berry, Citrophyllum eocenicum Berry, and Thrinax eocenica Berry.[3]

The Yegua formation forms a heavy black soil and a rolling topography. Mesquite timber is quite common.[4]

Cook's Mountain.- The thickness of the Cook's Mountain formation is about 400 feet. This formation lies conformably above the Mount Selman formation and beneath the Yegua formation. It consists largely of glauconitic sand and marl with some iron ore, green sand, and lignite. These beds are palustrine to marine. Marine fossils are common, some of the more characteristic being:- Corbula deusseni Gardner, Corbula smithvillensis Harris, Phos texanus Gabb, Dentalium minutistriatum Gabb, Turritella nasuta Gabb, Latirus moorei Gabb, Mesalia claibornensis, Harris, and Anomia ephippiodes Gabb.[5]

The Cook's Mountain formation forms a red sandy clay soil and a rolling topography, with a preponderance of post oak and black jack timber.[6]

Mount Selman.- The thickness of the Mount Selman formation is about 500 feet. The Mount Selman formation lies unconformably above the Carrizo formation and conformably below the

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3. Deussen, A., Ibid., pp.79.
4. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 830.
5. Deussen, A., "The Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924.
6. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XL., p. 830.

Cook's Mountain formation. It consists largely of ferruginous, coarse-grained sandstone with lenses of lignite and clay. The beds are lacustrine. Fossils are not numerous, the more common ones being Venericardia planicosta Lamarck, Plejona petrosa Conrad, Cornulina armigera (Conrad), none of which, however, are characteristic of these beds.[7]

With the exception of the basal beds, these strata make for a sandy soil and a rolling topography. The basal sandstones form northwestward facing escarpments. Blackjack and post oak timber is the most common.[8]

Beds of the foregoing Yegua, Cook's Mountain, and Mount Selman formations were not encountered in the wells which were considered in this paper. These formations outcrop in the eastern part of the county, and but few of the Caldwell County wells have penetrated them.

Wilcox Group

Carrizo.- The thickness of the Carrizo formation is about 250 feet. This formation lies unconformably on the Indio formation and unconformably below the Mount Selman formation.[9] The Carrizo beds are made up of laminated micaceous sand and

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7. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 62.

8. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 831.

9. Deussen, A., "The Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 59.

clay and massive cross-bedded sandstones. Lignite, petrified wood, concretions, and sandstone ledges are characteristic. Fossil plants are not uncommon. The beds are distinctly lacustrine.

This formation gives rise to a light sandy soil with a rolling topography. Post oak, blackjack, and hickory timber is most common.[10]

Like the foregoing Claiborne formations, these beds outcrop too far to the east to be considered in detail in this report.

Indio.-The Indio formation lies conformably on the Midway formation and unconformably beneath the Carrizo formation. The upper beds are made up of sandy concretionary shales. The middle beds consist of soft micaceous sandstones, laminated sandy shales and lignitic and lignite bearing shales. The lowermost beds consist of 100 to 200 feet of laminated fine grained sands and shales with concretionary boulders. These beds are massive and lacustrine.[11] The more common invertebrates are:- Ostrea tasex Gardner, and Venericardia planicosta?. Some of the common leaves found in this formation are Dillenites texensis, Euonymus splendens, Ficus spectabilis Lesquereux, and

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10. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. IX, p. 640.
11. Brucks, E. W., Ibid., p. 639.

<u>Terminalia</u> <u>hilgardiana</u> (Lesquereux).[12]

The Indio forms a sandy to clay soil and a rolling topography with post oak and blackjack timber of the sandy, and mesquite timber on the clay soils.[13]

Without the aid of paleontology the proper correlations and determinations of the Tertiary formations can hardly be made. However, there are some few distinctions which the drillers seldom miss. Thickening, thinning, and lithologic changes are almost impossible of determination from the log alone. The Indio beds are most often logged by experienced drillers as "shale and boulders". The boulders are extremely hard and of a flattened shape, and consequently they are the cause of considerable trouble in drilling. In the accompanying cross sections only general determinations of these beds could be made.

Collingwood and Rettger estimate the basal part of the Indio to be from 300 feet to 400 feet thick at Lytton Springs.[14] Brucks estimates the Indio to be 1250 feet in thickness on the

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12. Deussen, A., "The Geology of the Coastal Plain of Texas West of the Brazos River", <u>United States Geological Survey Professional Paper 126</u>, 1924, p. 49.

13. Brucks, E. W., "<u>The Geology of the San Marcos Quadrangle, Texas</u>", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. XI, p. 831.

14. Collingwood, D. M., and Rettger, R. E., "The Lytton Springs Oil Field, Caldwell County, Texas", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. X, p. 955.

surface in the San Marcos quadrangle.[15]

Midway.- The Midway formation rests unconformably on the Cretaceous and conformably (?) below the Wilcox beds. It is made up of clay, limestone, and green sand of marine origin. The clay is dark and carries concretions. The basal few feet consist of glauconitic green sand. The beds are of marine origin. The more important fossils are Enclimatoceras ulrichi White, Ostrea pulaskensis Harris, Cucullaea macrodonta Whitfield, Plejona limopsis (Conrad), Ostrea crenulimarginata Gabb,[16] Venericardia alticosta, Nodosaria sp., and Cristellaria sp..

The Midway formation makes for a heavy black clay soil, rolling topography, and mesquite timber.[17]

As has been previously mentioned, the Tertiary beds are difficult to determine from well logs alone. This fact may be further demonstrated by the Midway formation. With the use of paleontology, however, it is thought that much could be learned concerning the subsurface stratigraphy of these beds. This formation is ordinarily logged as "sticky shale", and it drills very slowly.

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15. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 831.

16. Deussen, A., "The Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 43.

17. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 831.

According to Brucks the Midway is about 280 feet thick at Luling,[18] and inthe San Marcos quadrangle generally.[19] Sellards estimates the Midway to be about 300 or 350 feet thick at Luling.[20] McCollum, Cunningham, and Burford state that this same formation is approximately 600 feet thick at Salt Flat.[21] Collingwood and Rettger estimate its thickness to be about 350 to 450 feet in the vicinity of Lytton Springs.[22] Apparently there is considerable variation in the thickness of these beds.

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18. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. IX, p. 643.

19. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 831.

20. Sellards, E. H., "The Luling Oil Field in Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XIV, p. 785.

21. McCollum, L. F., Cunningham, C. J., and Burford, S. O., "Salt Flat Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XIV, p. 1405.

22. Collingwood, D. M., and Rettger, R. E., "The Lytton Springs Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. X, p. 955.

Cretaceous System

Gulf Series

Navarro.- The thickness of the Navarro formation varies from 500 to 600 feet. The Navarro formation lies conformably on the Taylor formation and unconformably below the Midway formation. This formation consists of bluish-black marls and clay containing lenses of calcareous sandstone and siliceous limestone. The upper beds are characterized by the fine-grained, cross- and evenly-bedded sandstones which occur in lenses. The formation is largely marine.[23] Some of the more important fossils are:- *Exogyra costata* Say, *Gryphaea vesicularis* Lamarck, *Ostrea larva* Larmarck, *Sphenodiscus lenticularis* (Owen), and *Cristellaria* sp..[24]

The Navarro forms a black soil, a rolling topography, and mesquite timber.[25]

The contact of this formation with the underlying Taylor has not been determined with any degree of accuracy.

This formation is generally logged as "gumbo","black shale","blue shale", "shale", "soapstone", "clay", etc.

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23. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", *Bulletin of the American Association of Petroleum Geologists*, Vol. XI, p. 183.
24. Deussen, A., "The Geology of the Coastal Plain of Texas West of Brazos River", *United States Geological Survey Professional Paper 126*, 1924, p. 37.
25. Brucks, E. W., "The Geology ofthe San Marcos Quadrangle, Texas", *Bulletin ofthe American Association of Petroleum Geologists*, Vol. XI, p. 183.

Taylor.- The thickness of the Taylor formation varies from 500 to 800 feet. The Taylor formation rests conformably upon the Austin formation and below the Navarro formation. It consists largely of calcareous clay or marl with a few thin lenses of limestone and sandstone. The clay is very compact and massive and contains a small amount of sand. The beds are for the most part of marine origin. Some vertebrates have been found in the Taylor. A few of the more common invertebrates are:- Exogyra ponderosa Roemer, Inoceramus sp., and Gryphaea vesicularis Lamarck.[26]

The Taylor forms a black waxy soil and a rolling topography. Some mesquite grows on this formation.[27]

The lower portions of the Taylor are composed of thick beds of calcareous marl which resembles the Austin chalk. In fact, the bottom of the Taylor and the top of the Austin forms a very poor marker in subsurface work, and it should never be used when there is something better. The lithological change is most often a gradual one, and the paleontological facts have never as yet been accumulated and recorded so that they may be of use. These beds are usually logged as "sticky shale" of "hard, sticky shale". McCollum, Cunningham and Burford remark that the lower 100-150 feet of the Taylor is made up

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26. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River," United States Geological Survey Professional Paper 126, 1924, p. 33.

27. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 832.

of a chalky marl which is separated by shale and softer marl beds, and it is commonly termed the Taylor chalk. This material often appears in the well cuttings as the Austin chalk material beneath it, and the behavior of the drill suggests the Austin chalk. Furthermore, after penetrating about 40 feet of this material, a 15-20 foot shale bed is reached, which sometimes causes the driller to erroneously log a short section of Austin chalk with a normal section of the Eagle Ford formation beneath it.[28]

Austin.- The thickness of the Austin formation has been variously estimated as being from 200 to 350 feet in this county.

The true thickness of the Austin presents quite a problem. As has been previously remarked, the contact with the Taylor is very problematical. Brucks says that the top and the base of the Austin are characterized by the presence of glauconite and oil stains.[29] Sellards, however, remarks that some layers have been observed in the Austin, which present quite a resemblance to the Georgetown, and the staining of the rock and its gray color only tend to substantiate that fact.[30]

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28. McCollum, L. F., Cunningham, C. J., and Burford, S. O., "Salt Flat Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XIV, p. 1006.

29. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. IX, p. 644.

30. Sellards, E. H., "The Luling Oil Field in Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. VIII, p. 784.

Deussen defines the Austin formation as consisting of strata of impure chalk, carrying about 85 per cent of calcium carbonate, and interstratified with beds of softer marl. Some of the microscopic features of the rock are oolitic granules, calcite crystals, particles of amorphous calcite, and the shells of Foraminifera, molluscs, and echinoids.[31] Some of the more common fossils are _Inoceramus undulato-plicatus_ Roemer, _Mortoniceras texanum_ (Roemer), _Exogyra ponderosa_ Roemer, _Exogyra laeviuscula_ Roemer, _Gryphaea aucella_ Roemer, _Radiolites austinensis_ Roemer, _Eutrephoceras_ sp., and _Ostrea_ aff. _Ostrea diluviana_.[32]

From the accompanying cross sections, it may be inferred that there are local variations in the thickness of the Austin (granting that the wells are logged with fair accuracy), but it is also true that there is a general southeastward thickening of the Austin. Thus, in sectionA-A' the Austin is 332 feet thick in well #5, and it is 362 feet thick in well #29 which is 5½ miles to the southeast. In section B-B' the Austin is 260 feet thick in well #2 and 336 feet thick in well #7 which is about 7½ miles to the southeast. In section C-C' the Austin is about 216 feet thick in well #3 and is 263 feet thick in #5 at a distance of nearly 5 miles to the southeast. In section D-D' the Austin is 211 feet thick in well #2 and 230 feet thick

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31. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 31.

32. Deussen, A., _Ibid_., p. 26.

in well #11 at a distance of nearly 15 miles to the southeast. In Section F-F' the Austin is 263 feet thick in well #1 and 293 feet thick in well #16 at a distance of nearly 13 miles to the southeast.

However, it has been observed that in the area between the Balcones fault system and the Luling-Mexia fault system, there is a structural depression which may be considered a graben. It is notably true that the Austin thickens to the southeastward into this depression; but when it is encountered in the Luling field and in the Salt Flat field, it is found to be considerably thinner than it was in the graben to the west. Thus, in section E-E' the Austin is 304 feet in well #4 and 257 feet thick in well #5, the former of which is located about 2½ miles west of the Luling field, and the latter of which is in the Luling field. In section F-F' the thickness of the Austin in well #7 is 287 feet, and in well #13 which is to the southeastward and is in the Luling field, the Austin thickness is 196 feet. In spite of this apparently contradictory data, it is true that the Austin does thicken to the southeastward, and it seems that the thick section in the graben to the west of the Luling fault and the thin section on the upthrow side adjacent to the fault is the result of local variation, and might have been caused by faulting in Austin time. Collingwood and Rettger have observed that the Austin formation is much thinner on the upthrow side and much thicker on the downthrow side (apparently) of the Fault at Lytton Springs.[33] Brucks has observed that the interval from the top of the Austin to the top of the Edwards shows a considerable increase southeastward from the Hohenburg test in Hays county to the Luling field.[34]

Furthermore, section N-S shows rather clearly that the Austin thickens to the northeastward as well as to the southeast. In every case, it seems that the Austin thins out to the northwest, west, and southwest. Thus in section N-S the Austin thickness in well #1 is some 165 feet thicker than in well #6 which is about 20 miles to the southwest. That this conclusion is fairly accurate is demonstrated by the fact that the change is gradual and not abrupt.

All of this evidence is dependent upon a certain amount of faith in the belief that the thickness of the Austin formation can be determined with fair accuracy from well logs and samples, an assumption which seems reasonable so long as the wells are distributed over quite an area.

Eagle Ford.- The Eagle Ford formation has been estimated by various authors as having a thickness of from 10 to 60 feet in Caldwell county.

This formation is characterized by black to grayish-yellow

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33. Collingwood, D. M., and Rettger, R. E., "The Lytton Springs Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. X, p. 958.

34. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 841.

finely to coarsely laminated shale, with thin lenticular limestone flags. It is slightly bituminous, gas and oil having been obtained at this horizon.

Some of the more common fossils are:- Metoicoceras whitei Hyatt, M. swallowi Shumard, Ostrea lugubris Conrad, Inoceramus fragilis H. & M., I. labiatus Schlotheim, and Ostrea congesta Conrad.[35]

From a consideration of the cross sections the inference would be that the Eagle Ford thickness is locally variable; that ti shows a slight tendency to thicken on the down throw and thin out on the upthrow side of faults; and that if it thickens generally to the southeastward, as the Austin, the evidence at hand does not corroborate such an observation. It is possible that the confusion relative to the Eagle Ford thickness is due to the improper logging of wells. It is more probable, however, that the results here obtained are indicative of an unconformity's existence between the Eagle Ford and the Buda.

Comanche Series

Buda.- The thickness of the Buda formation has been variously estimated as being from 30 to 82 feet.

The Buda formation consists of a hard, dense, semi-crystal-

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35. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 24.

line, gray-to-dark-gray limestone.[36] ~~G~~lauconite is often present in it, and it is quite often that portions of it are chalky.[37] The Buda is of Marine origin and contains fossils, some of the more common of which are Pecten roemeri Hill, Exogyra n. sp., Gryphaea mucronata Gabb, and others.[38]

From an examination of the cross sections it seems evident that the Buda formation is locally variable; that it increases in thickness on the upthrow side of faults quite as often as it does on the downthrow; and that there is nothing to convince one that it thins or thickens perceptibly in any given direction. Section N- S reveals that it may thin to the northward and thicken to the southward; this statement is based essentially upon the evidence offered by well #1, and hence it is possibly incorrect.

As in the case of the Eagle Ford, these erratic changes might have been the result of the uncomformities which occur between the Gulf and the Comanche series.

Del Rio.- The thickness of this formation has been estimated by numerous authors to be from 45 to 100 feet.

The Del Rio formation is a plastic, slightly calcareous

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36. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 832.

37. Sellards, E. H., "The Luling Oil Field, in Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. VIII, p. 783.

38. Adkins, W. S., and Arick, M. B., "Geology of Bell County, Texas", Universtiy of Texas Bulletin No. 3016, 1930 p. 52.

shale. Mudh of the clay is gypsiferous, pyritic, or hematitic, and it is somewhat calcareous. When it is fresh it is dark blue; when it is weathered, it is a light gray. The pyrite hydrates and oxidizes to diffused iron stains and streaks.[39] This is a marine formation. Some of the most characteristic fossils are _Exogyra arietina_ Roemer, and _Gryphaea mucronata_ Gabb. The Del Rio- Buda contact is often difficult to determine. Likewise, the Del Rio-Georgetown contact is difficult of determination. In both cases an accurate determination is dependent largely upon the paleontology. This formation is ordinarily logged as "gumbo", and it isnusually difficult to drill.

Dr. Sellards has remarked that between the Austin and the Edwards formations, the Del Rio is probably the variable in thickness of all of the formations.[40] From the accompanying cross sections this feature of the Del Rio is rendered still more obvious. Thus, in section A-A' the Del Rio is represented as assuming a great thickness on the downthrow side ofa fault (well #29); a considerable thickness on the upthrow side of a fault (well #5); and a considerable decrease in thickness on the upthrow side of a fault (well #31). Itmmust be observed, however, that in most cases the Del Rio exhibits a tendency to thicken to the southeastward.

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39. Adkins, W. S., and Arick, M. B., _Ibid._, p. 47.
40. Sellards, E. H., "The Luling Oil Field in Caldwell County, Texas", _Bulletin of the American Association of Petroleum Geologists_, Vol. VIII, p. 783.

<u>Georgetown</u>.- The various authors have estimated the Georgetown formation to vary in thickness from 50 to 80 feet in Caldwell county.

The Georgetown consists of rather massive grayish-yellow limestones of Marine origin.[41] It is composed of layers of softer marls between the harder rock ledges. It is very fossiliferous at the top. Thin sections reveal that the Georgetown is a very dense, coarse-grained limestone and contains imbedded shell fragments and well preserved shells. In the upper parts glauconite is not uncommon. Some of the more common fossils are:- <u>Kingena wacoensis</u> (Roemer), <u>Turrilites brazoensis</u> Shumard, <u>Gryphaea washitaensis</u> Hill, and <u>Alectryonia carinata</u> (Lamarck).[42]

In the drilling of wells in Caldwell county a fairly accurate determination of the Georgetown formation is almost essential. It is in the lower portions of the Georgetown that the casing is set and cemented before proceeding into the underlying Edwards. The top of the Georgetown is usually considered to be encountered when the bit drills solidly in a hard limestone. This formation is usually hard of drilling, and the bit hangs and jumps; much pyrite is found near the fault, and this feature

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41. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. XI, p. 832.

42. Sellards, E. H., "The Luling Oil Field in Caldwell County, Texas", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. VIII, pp. 780-782.

of the drilling is rendered still more apparent.[43]

The inaccuracy of determination of the top of the Georgetown causes the use of cross sections to be a bit dubious. However, such data as they do offer seem to be more orlless consistent and self sustaining. Thus, in section N-S the Georgetown has a thickness of about 45 feet in well #1; thins to about 30 feet in well #2 which is structurally high; thickens to about 65 feet in well #3, which is structurally low; and then thins as it encounters the "high" upon which well #4 was located, from which it gradually thickens to the southward, until it reaches the thickness of about 65 feet in well #6, which is on the upthrow side of a pronounced fault. Section D-D' gives evidence (which is a bit confused) that the formation thickens to the southeastward. This feature is corroborated by sections A-A', E-E', and F-F'. It is not corroborated by sections B-B' and C-C'.

<u>Edwards</u>.- The Edwards formation is thought to be about 500 feet in thickness.

The Edwards consists of massive, dense, gray, fractured marine limestone, containing chert concretions. The upper part is known to consist of a dolomitic limestone with a variable porosity up to 30 per cent. The porous part, however, is often encountered within 15-30 feet of the top of the formation.[44]

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43. McCollum, L. F., Cunningham, C. J., and Burford, S. O., "Salt Flat Oil Field, Caldwell County, Texas", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. XIV, p. 1408.

The "dobe" phase of the formation occurs near the top and usually consists of white, soft, marly material which is essentially nonfossiliferous. Some strata consist practically in their entirety of milioline foraminifera which, being lighter than their matrix, appear as minute specks in the light-gray field.[45] This formation furnishes one of the most lucrative horizons for oil accumulation in Caldwell county. Shells of the genus Requienia are common.

In view of the fact that only a few of the wells in Caldwell county have drilled the full thickness of the Edwards, the use of the cross sections for stratigraphic purposes is very limited indeed. Differentiation of the Edwards from the underlying formations was not attempted.

Comanche Peak, Walnut, Glen Rose, and Travis Peak:- These formations have seldon been penetrated by the drill, in Caldwell county. The log of the C. T. Schawe well at Maxwell, Texas presents the following section, as determined by Deussen:[46]

Georgetown, Edwards, and Comanche Peak, consisting of brown, white, and gray rock, the upper portion being porous;

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44. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. IX, p. 645; also "The Geology of the San Marcos Quadrangle, Texas", Ibid., Vol. XI, p. 832.
45. Sellards, E. H., "The Luling Oil Field in Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. VIII, p. 779.
46. Deussen, A., "Geology of the Coastal Plain of Texas West of Brazos River", United States Geological Survey Professional Paper 126, 1924, p. 39.

and the lower portion being hard, for the most part brown, and with white layers. Thickness, 943 feet.

Walnut, consisting of gumbo. Thickness, 8 feet.

Glen Rose, consisting of brown, white, and gray, hard and soft rock with some sand. Thickness, 671 feet.

Travis Peak, consisting of white and yellow sand with red and blue shales. Thickness, 691 feet.

Brucks estimates the Glenrose to be 1450 feet thick and the Trinity or basement sands (Travis Peak) to be about 500 feet thick at Luling.[47]

The Top Austin - Top Edwards Interval

Brucks has mentioned that in the San Marcos quadrangle there is a tendency for the interval between the top of the Austin formation and the top of the Edwards formation to become all thicker to the southeastward.[48] This fact has become all the more obvious from the cross sections which were constructed in the preparation of this paper. Thus in section B-B' the interval in well #2 is 430 feet, and in well #7 the interval is better than 480 feet, well #7 being about 7.3 miles southeast of #4. In section D-D' the interval in well #2 is about 345 feet, while in well #11, which is about 14.3 miles to the southeast, the in-

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47. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 646.

48. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XI, p. 841-842.

terval is about 390 feet. Likewise in well #1 of section F-F' the interval is about 395 feet, while in well #16 which is about 12 miles to the east-southeast the interval has increased to about 450 feet. It seems that this interval, as demonstrated by section N-S, may increase in thickness toward the northeast, but closer examination will reveal that this increase in thickness in confined practically entirely to the Austin chalk.

Igneous, Altered Igneous, and Metamorphic Rocks

Serpentine.- Serpentine has been encountered in numerous wells in Caldwell county. The Lytton Springs townsite field, the Lytton Springs field, the Dale field, the Brown-Cude field, and numerous individual wells have obtained their oil from this horizon.

The thickness of the serpentine varies from a very thin bed to a massive bed of hundreds of feet. The serpentine is a "dull greenish fragmental rock composed largely of serpantine and chloritic minerals."[49] The origin, occurence, and nature of serpentine has been discussed at length by numerous authors and need not be dealt with in this paper. Suffice it to say that its stratigraphic position is at the base of the Taylor formation and at the top of the Austin formation, and that it replaces a greater or lesser amount of one or both of these formations.

Section A-A' illustrates how the serpentine occurs succes-

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49. Lonsdale, J. T., "Igneous Rocks of the Balcones Fault Region of Texas", University of Texas Bulletin No. 2744, 1927, p. 128.

sively down the sloping beds of the Taylor and Austin formations, and how it occupies about the same stratigraphic position in each case. It shows further the doming of the serpentine over the highs on which the oil fields occur.

Basalt.- This material has been reported from two wells in the Dale oil field. It was in contact with the serpentine. In texture it is very similar to the nephelite basalt of Pilot Knob, in Travis county. (Personal communication with Mr. R. T. Short).

Schist.- Schist has been found in at least three wells in Caldwell county: the Tabor #8, the Kelley #1, and the Tiller #2 drilled by the United North and South Oil Company, in the Luling oil field. It was found to underlie the Travis Peak formation. The chief constituents are silica, 55.13%; aluminium oxide, 27,31%; iron oxide, 5.33%; potassium oxide, 3.46%; magnesium oxide, 1.46%; and sodium oxide, 1.07%. In the drilling of these rocks the drilling mud became highly heated and had to be cooled continually.[50]

These rocks are probably of pre-Paleozoic age.

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50. Brucks, E. W., "The Luling Field, Caldwell and Guadalupe Counties, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. IX, 1925, pp. 646-647.

STRUCTURAL GEOLOGY

Between the Balcones system on the west and the Luling-Mexia system on the east, there exists what seems to be a graben, consisting of a number of tilted blocks. One of chief purposes of this paper is to present some of the anomalies which have been observed, relevant to the thicknesses of the beds in this graben and adjacent to it along the bordering fault lines.

In the study of the geological conditions of Caldwell county, the faulting in the Luling Mexia system demands the most emphasis. In this system a number of separate faults are involved, many of which have been described in the literature. In the literature, however, there has been a tendency to emphasize the faults with the upthrow to the sea; this is due to the economic value of some faults of this kind. It must be undoubtedly true that some of the steep seaward dips witnessed in the cross sections considered in this paper, are due to faults which are upthrown to the west and north west, and which, because of lack of economic value, have never been put into print. It is entirely possible that they have never been mapped.

Brucks designated the following faults: Staples-Lytton Springs fault, Lytton Springs Oil Field fault, Burdette Wells fault, Cibolo fault, Dale fault (possibly), and Manford fault.[51] McCollum, Cunningham, and Burford have demonstrated the Salt

51. Brucks, E. W., "The Geology of the San Marcos Quadrangle, Texas", <u>Bulletin of the American Association of Petroleum Geologists</u>, Vol. XI, pp. 833-840.

Flat field.[52] Collingwood and Rettger have made a thorough study of the faulted situation at the Lytton Springs Oil field.[53] Various other authors have likewise studied and mapped these and other faults in the area.

In the accompanying cross sections many of the aforementioned faults have been detected, and there is evidence shown of the existence of still others. The profiles will be considered in their order, as follows:

Section A-A'.- A fault probably occurs between wells #3 and #4. The displacement would be about 200 feet, in the Austin chalk.

A fault probably occurs between wells #4 and #5. An alternative, of course, would be an anticline in the vicinity of well #5. If a fault, it has a displacement of about 300 feet in the Austin chalk.

In well #7 the Austin rests directly upon the Edwards. The fault involved has, therefore, a displacement of from 200 to 250 feet.

A fault probably passes between wells #29 and #31. If so, the displacement would be about 330 feet in the Austin .

Where uninterrupted by faulting, the beds seem to be dip-

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52. McCollum, L. F., Cunningham, C. J., and Burford, S. O., "Salt Flat Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XIV, pp. 1401-1423, 1930.

53. Collingwood, D. M., and Rettger, R. E., "The Lytton Springs Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. X, pp. 958-960.

ping to the southeast at a rate of about 200 feet to the mile.

Section B-B'.- No faulting was observed. The beds seem to be dipping to the southeast at a rate varying from 110 to 125 feet to the mile.

Section C-C'.- A fault cuts the lower part of well #1 and probably #2 and passes downward to the west of #1. The displacement is at least from 280 to 380 feet, probably more, in the Austin chalk.

A small fault may cut well #5. The log of the well was poor.

A fault passes between wells #8 and #9 and possibly cuts the upper part of the Austin in #9. The displacement is at least 340 feet, probably more, in the Austin chalk.

The normal dip of the strata seems to be about 200 feet to the mile to the southeast.

Section D-D'.- A fault cuts well #6. The displacement is about 150 feet in the Austin chalk.

According to McCollum, Cunningham, and Burford, a fault should pass between wells #8 and #9.[54] This is not altogether clear from this section.

Three hundred feet to the mile may be the normal dip of the strata, to the southeast. However, it may be that there is some faulting with the downthrow to the sea, which accounts for such a steep dip.

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54. McCollum, L. F., Cunningham, C. J., and Burford, S. O., "Salt Flat Oil Field, Caldwell County, Texas", Bulletin of the American Association of Petroleum Geologists, Vol. XIV, pl. IV.

Section E-E'.- A fault passes between wells #1 and #2. The displacement is about 400 feet in the Austin chalk.

A fault passes between wells #4 and #5. The displacement is about 400 feet in the Edwards.

A fault is observed between wells #11 and #12, cutting the lower part of the Austin in #11. The displacement is about 300 feet measured on the bottom of the Austin.

The strata seem to dip normally at the rate of about 175 feet to the mile to the southeast.

Section F-F'.- A fault passes between wells #2 and #3. The displacement is atleast 400 feet.

A fault passes between wells #7 and #8 and truncates the upper part of the Austin in well #8. The displacement is about 400 feet in the Austin chalk.

The normal dip of the strata is about 270 feet to the mile to the southeast. This may be due to faults with downthrown sides to the sea, rather than the normal dip.

It is easily and readily observed that some of the faults which have been mentioned are coincident with those demonstrated by the various authors of the subject. Some, however, are new. The accompanying map and charts show the faults as they seem to occur.

RELATION OF FAULTING TO THICKNESS OF FORMATIONS.

The foregoing data render possible the conclusions that:-

1. The Austin formation thickens to the northeastward, eastward, and southeastward, in Caldwell county.

2. The Austin formation thins out on the upthrow side of faults and thickens on the downthrow, when the faults are upthrown to the sea.

3. The Eagle Ford formation is locally variable, but it often thickens on the downthrow and thins on the upthrow side of faults upthrown to the sea. No other conclusion is justified by the data at hand.

4. The Buda formation is locally variable in thickness.

5. The Del Rio formation possibly thickens to the southeastward, but it is locally variable.

6. The Georgetown formation seems to thicken to the south and southeastward. It may thin out on the upthrow side of faults; this, however, is doubtful.

It seems that considerable of the faulting in Caldwell county took place during Austin time, as evidenced by the behavior of the Austin along the fault line. Furthermore, the thickening on the downthrow and the thinning on the upthrow side of faults are phenomena which are hardly representative of the lower Cretaceous. Surface faults show some of the faults to be of Tertiary age. It seems evident that the Luling-Mexia fault system has been a line of weakness for a number of geologic ages.

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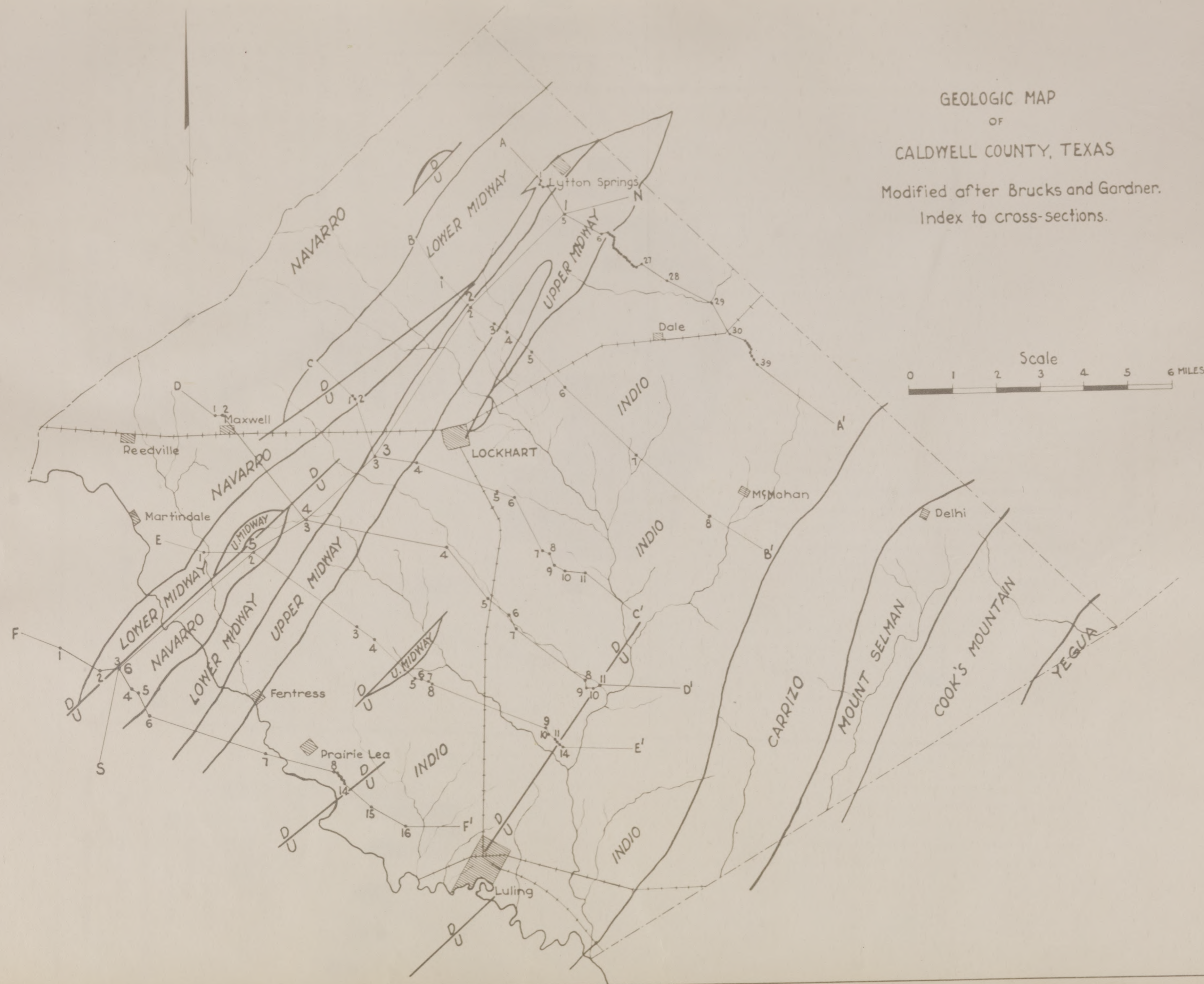
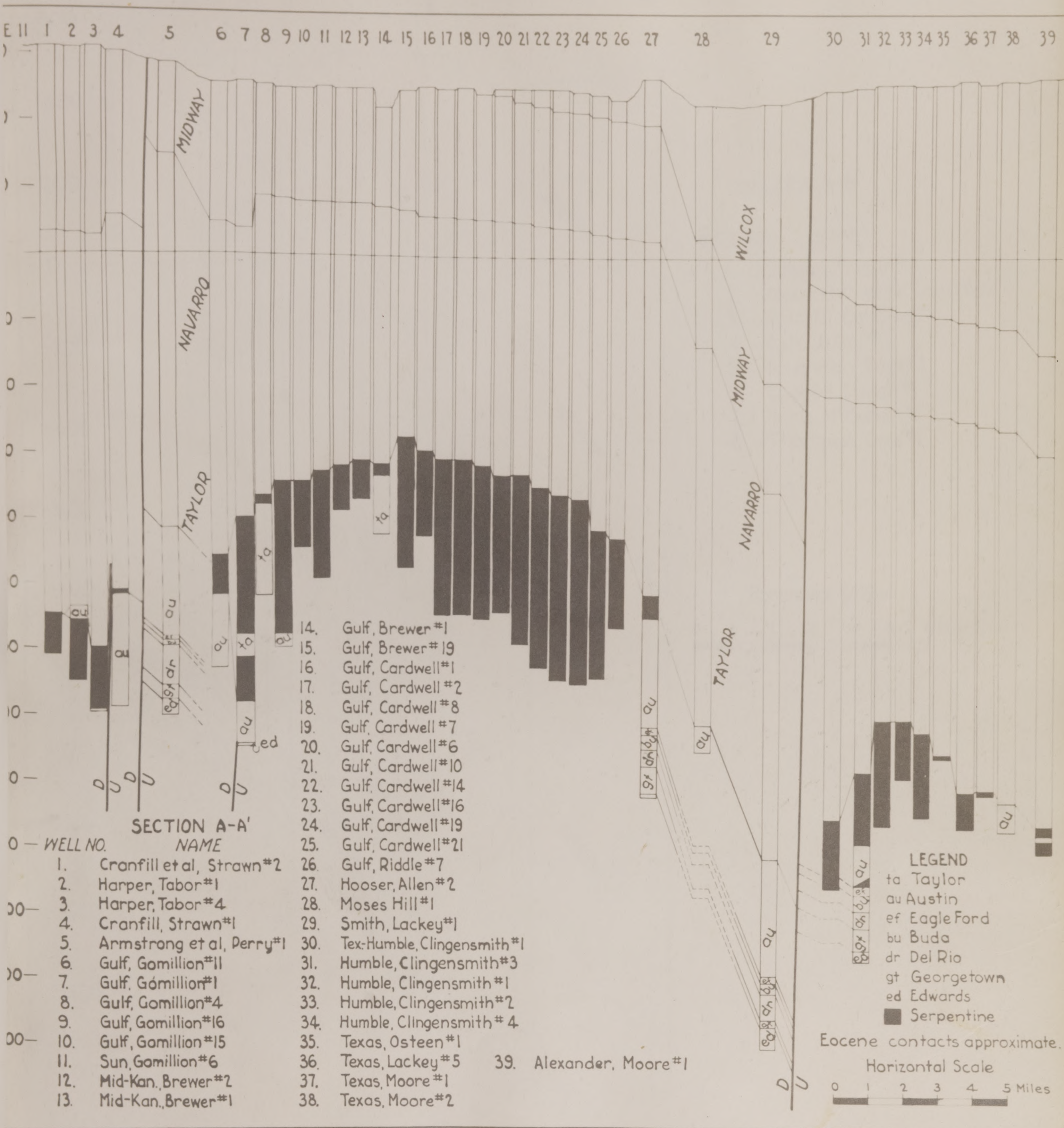
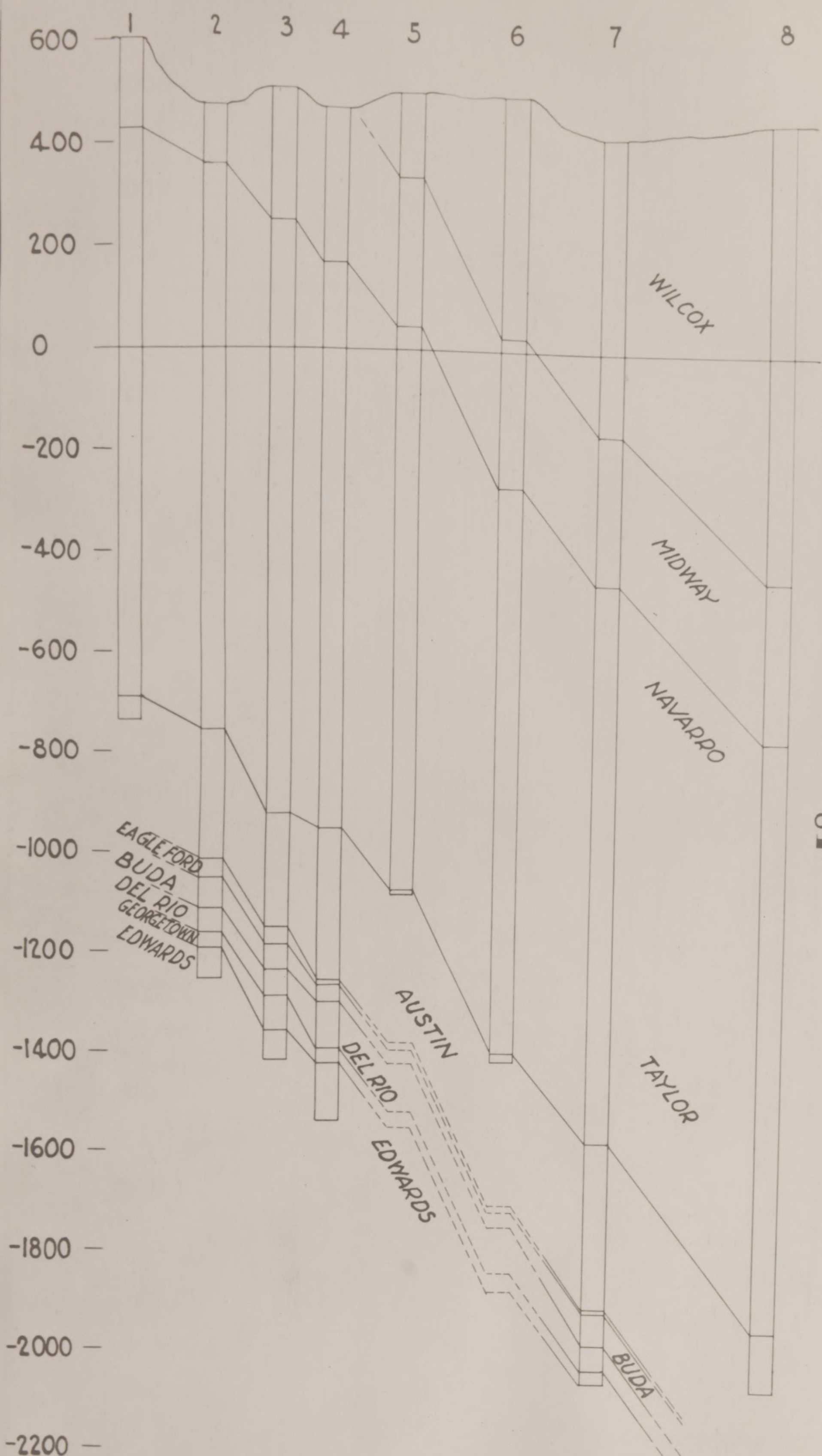
GEOLOGIC MAP
OF
CALDWELL COUNTY, TEXAS

Modified after Brucks and Gardner.
Index to cross-sections.





SECTION A-A'
WELL NO. NAME
1. Cranfill et al, Strawn #2
2. Harper, Tabor #1
3. Harper, Tabor #4
4. Cranfill, Strawn #1
5. Armstrong et al, Perry #1
6. Gulf, Gomillion #11
7. Gulf, Gomillion #1
8. Gulf, Gomillion #4
9. Gulf, Gomillion #16
10. Gulf, Gomillion #15
11. Sun, Gomillion #6
12. Mid-Kan., Brewer #2
13. Mid-Kan., Brewer #1
14. Gulf, Brewer #1
15. Gulf, Brewer #19
16. Gulf, Cardwell #1
17. Gulf, Cardwell #2
18. Gulf, Cardwell #8
19. Gulf, Cardwell #7
20. Gulf, Cardwell #6
21. Gulf, Cardwell #10
22. Gulf, Cardwell #14
23. Gulf, Cardwell #16
24. Gulf, Cardwell #19
25. Gulf, Cardwell #21
26. Gulf, Riddle #7
27. Hooser, Allen #2
28. Moses Hill #1
29. Smith, Lackey #1
30. Tex-Humble, Clingensmith #1
31. Humble, Clingensmith #3
32. Humble, Clingensmith #1
33. Humble, Clingensmith #2
34. Humble, Clingensmith #4
35. Texas, Osteen #1
36. Texas, Lackey #5
37. Texas, Moore #1
38. Texas, Moore #2
39. Alexander, Moore #1
LEGEND
ta Taylor
au Austin
ef Eagle Ford
bu Buda
dr Del Rio
gt Georgetown
ed Edwards
Serpentine
Eocene contacts approximate.
Horizontal Scale
0 1 2 3 4 5 Miles
MIDWAY
NAVARRO
TAYLOR
WILCOX



SECTION B-B'

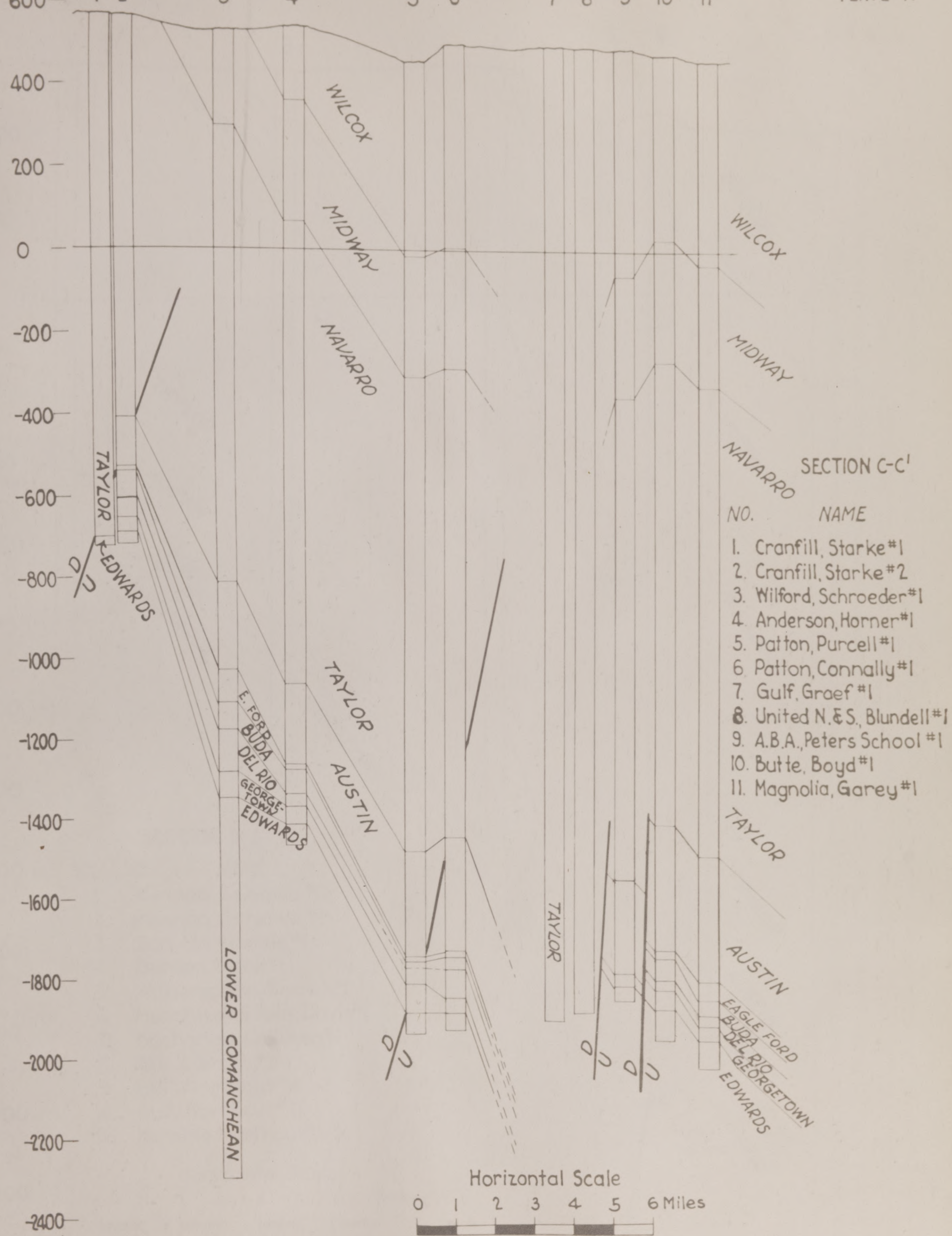
WELL NO. *NAME*

1. Simms, Masur #1
2. Alexander et al, Cardwell #1
3. Ratcliff, Cardwell #1
4. Ash, Jolley #1
5. Bauchman, Page #1
6. Caggoll, Lynch #1
7. Hertz, McMahon #1
8. Thorman, Cole #1

Horizontal Scale

0 1 2 3 4 5 6 Miles

PLATE IV


SECTION C-C'
NO. NAME
1. Cranfill, Starke #1
2. Cranfill, Starke #2
3. Wilford, Schroeder #1
4. Anderson, Horner #1
5. Patton, Purcell #1
6. Patton, Connally #1
7. Gulf, Graef #1
8. United N.&S., Blundell #1
9. A.B.A., Peters School #1
10. Butte, Boyd #1
11. Magnolia, Garey #1
WILCOX
MIDWAY
NAVARRO
TAYLOR
AUSTIN
E. FORD
BUDA
DEL RIO
GEORGETOWN
EDWARDS
EAGLE FORD
LOWER COMANCHEAN
D U
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
-2400
1 2 3 4 5 6 7 8 9 10 11
Horizontal Scale
0 1 2 3 4 5 6 Miles

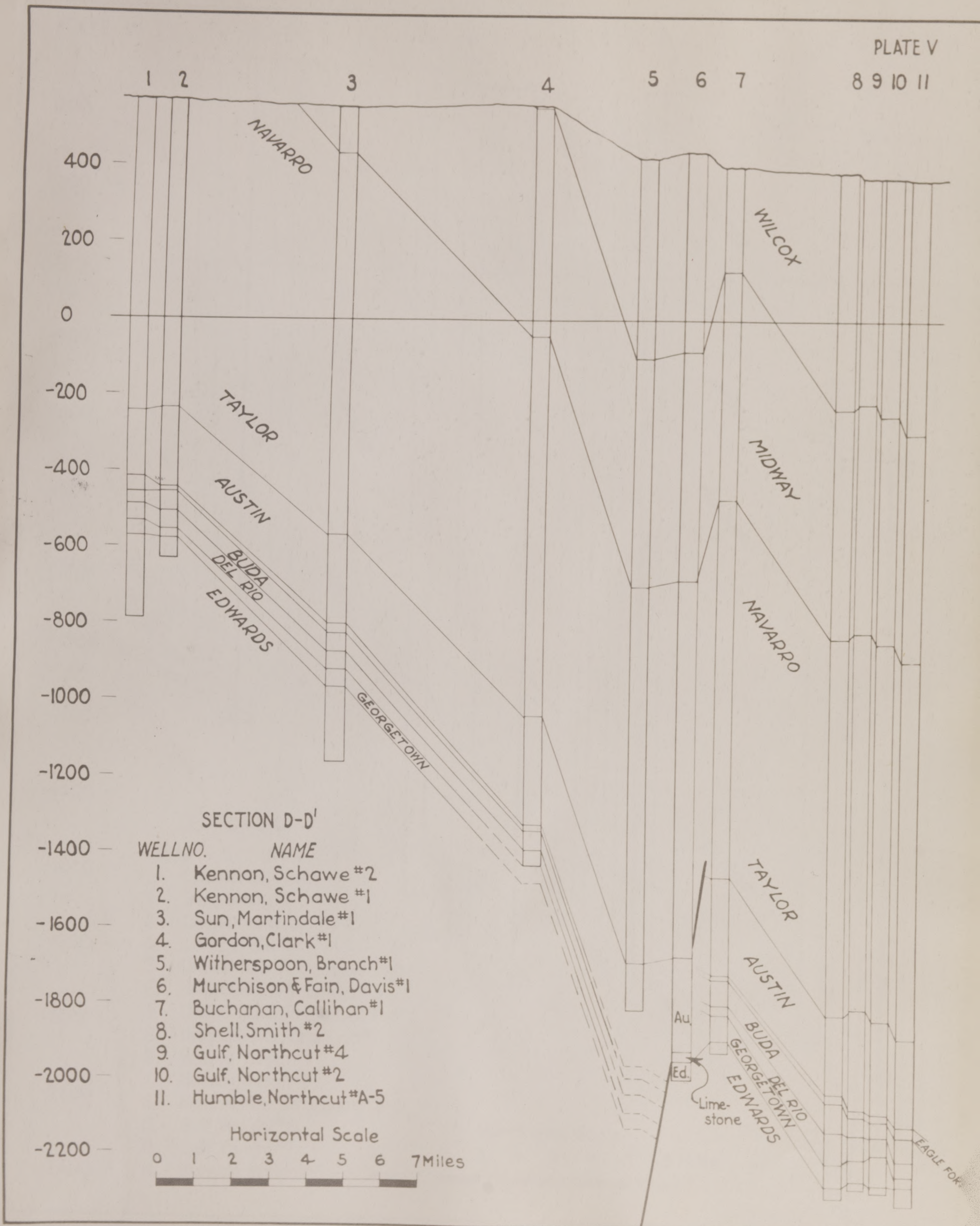


PLATE V
1 2 3 4 5 6 7 8 9 10 11
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
NAVARRO
TAYLOR
AUSTIN
BUDA
DEL RIO
EDWARDS
GEORGETOWN
WILCOX
MIDWAY
NAVARRO
TAYLOR
AUSTIN
BUDA
DEL RIO
GEORGETOWN
EDWARDS
Au.
Ed.
Lime-
stone
SECTION D-D'
WELL NO. NAME
1. Kennon, Schawe #2
2. Kennon, Schawe #1
3. Sun, Martindale #1
4. Gordon, Clark #1
5. Witherspoon, Branch #1
6. Murchison & Fain, Davis #1
7. Buchanan, Callihan #1
8. Shell, Smith #2
9. Gulf, Northcut #4
10. Gulf, Northcut #2
11. Humble, Northcut #A-5
Horizontal Scale
0 1 2 3 4 5 6 7 Miles

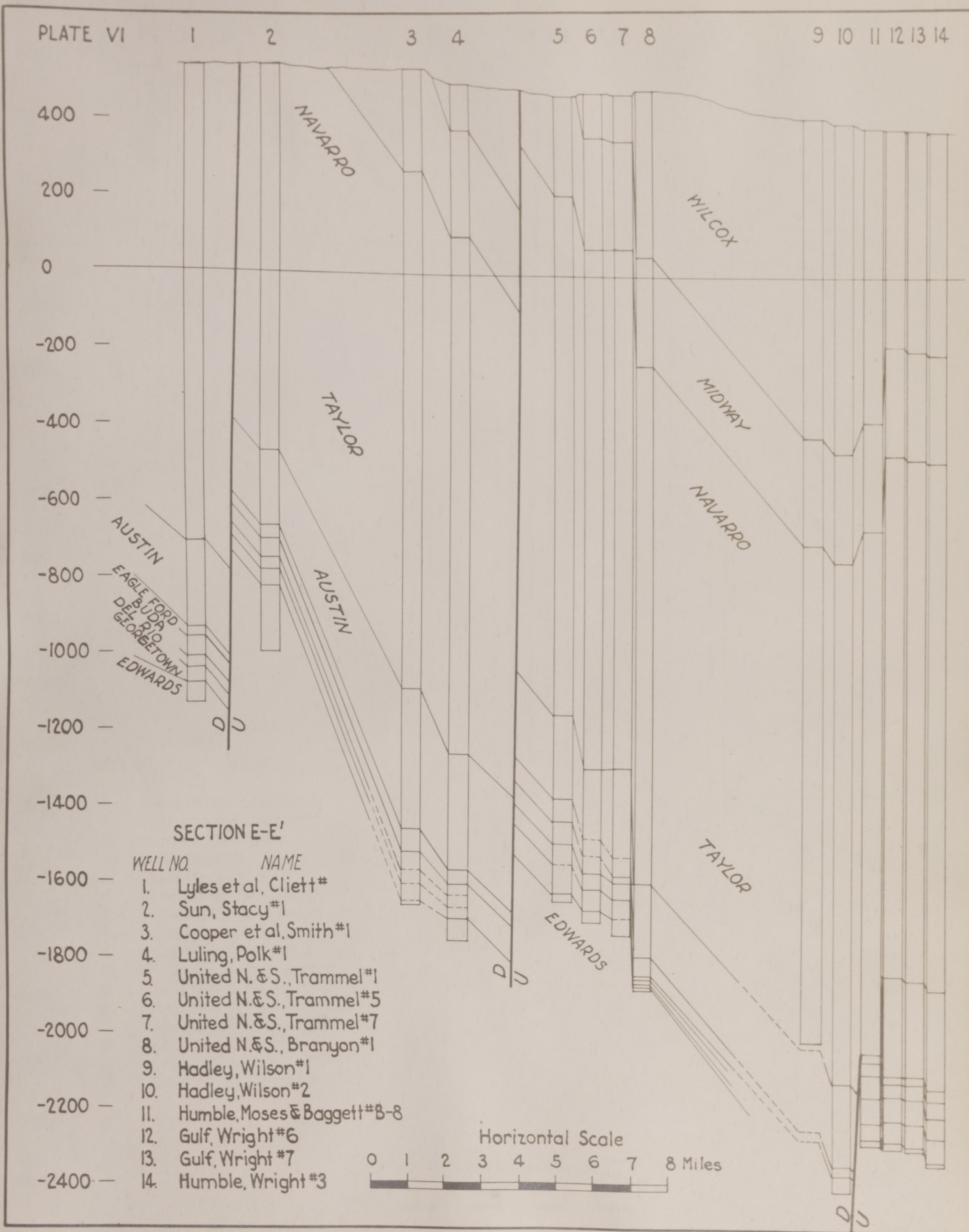
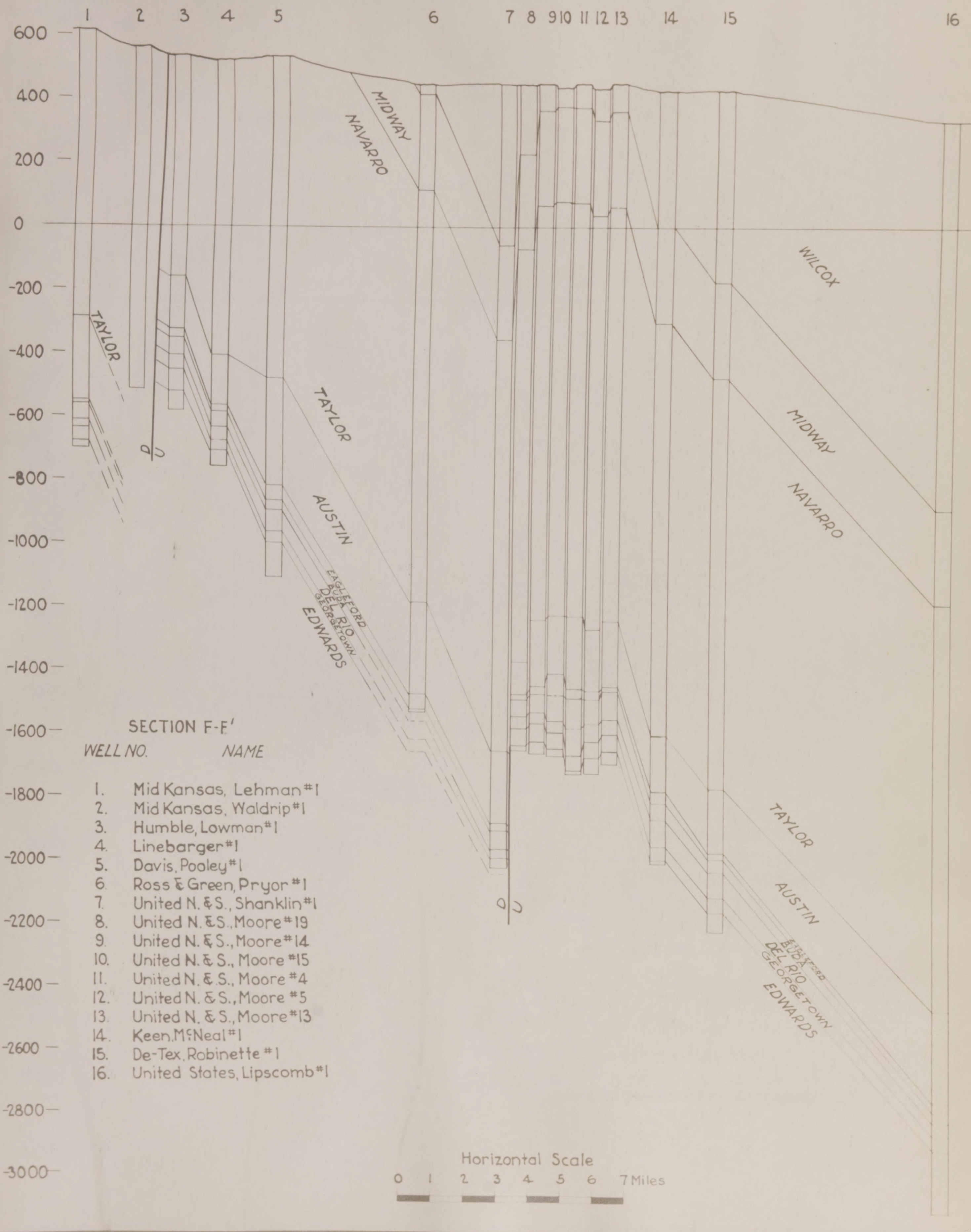


PLATE VI
1 2 3 4 5 6 7 8 9 10 11 12 13 14
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
-2400
NAVARRO
WILCOX
TAYLOR
MIDWAY
NAVARRO
AUSTIN
AUSTIN
EAGLE FORD
BUDA
DEL RIO
GEORGETOWN
EDWARDS
TAYLOR
EDWARDS
D U
D U
D U
SECTION E-E'
WELL NO. NAME
1. Lyles et al, Cliett #
2. Sun, Stacy #1
3. Cooper et al, Smith #1
4. Luling, Polk #1
5. United N. & S., Trammel #1
6. United N. & S., Trammel #5
7. United N. & S., Trammel #7
8. United N. & S., Branyon #1
9. Hadley, Wilson #1
10. Hadley, Wilson #2
11. Humble, Moses & Baggett #B-8
12. Gulf, Wright #6
13. Gulf, Wright #7
14. Humble, Wright #3
Horizontal Scale
0 1 2 3 4 5 6 7 8 Miles

PLATE VII


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
-2400
-2600
-2800
-3000
MIDWAY
NAVARRO
TAYLOR
TAYLOR
AUSTIN
EAGLE FORD
BUDA
DEL RIO
GEORGETOWN
EDWARDS
WILCOX
MIDWAY
NAVARRO
TAYLOR
AUSTIN
EAGLE FORD
BUDA
DEL RIO
GEORGETOWN
EDWARDS
D U
D U
SECTION F-F'
WELL NO. NAME
1. Mid Kansas, Lehman #1
2. Mid Kansas, Waldrip #1
3. Humble, Lowman #1
4. Linebarger #1
5. Davis, Pooley #1
6. Ross & Green, Pryor #1
7. United N. & S., Shanklin #1
8. United N. & S., Moore #19
9. United N. & S., Moore #14
10. United N. & S., Moore #15
11. United N. & S., Moore #4
12. United N. & S., Moore #5
13. United N. & S., Moore #13
14. Keen, McNeal #1
15. De-Tex, Robinette #1
16. United States, Lipscomb #1
Horizontal Scale
0 1 2 3 4 5 6 7 Miles

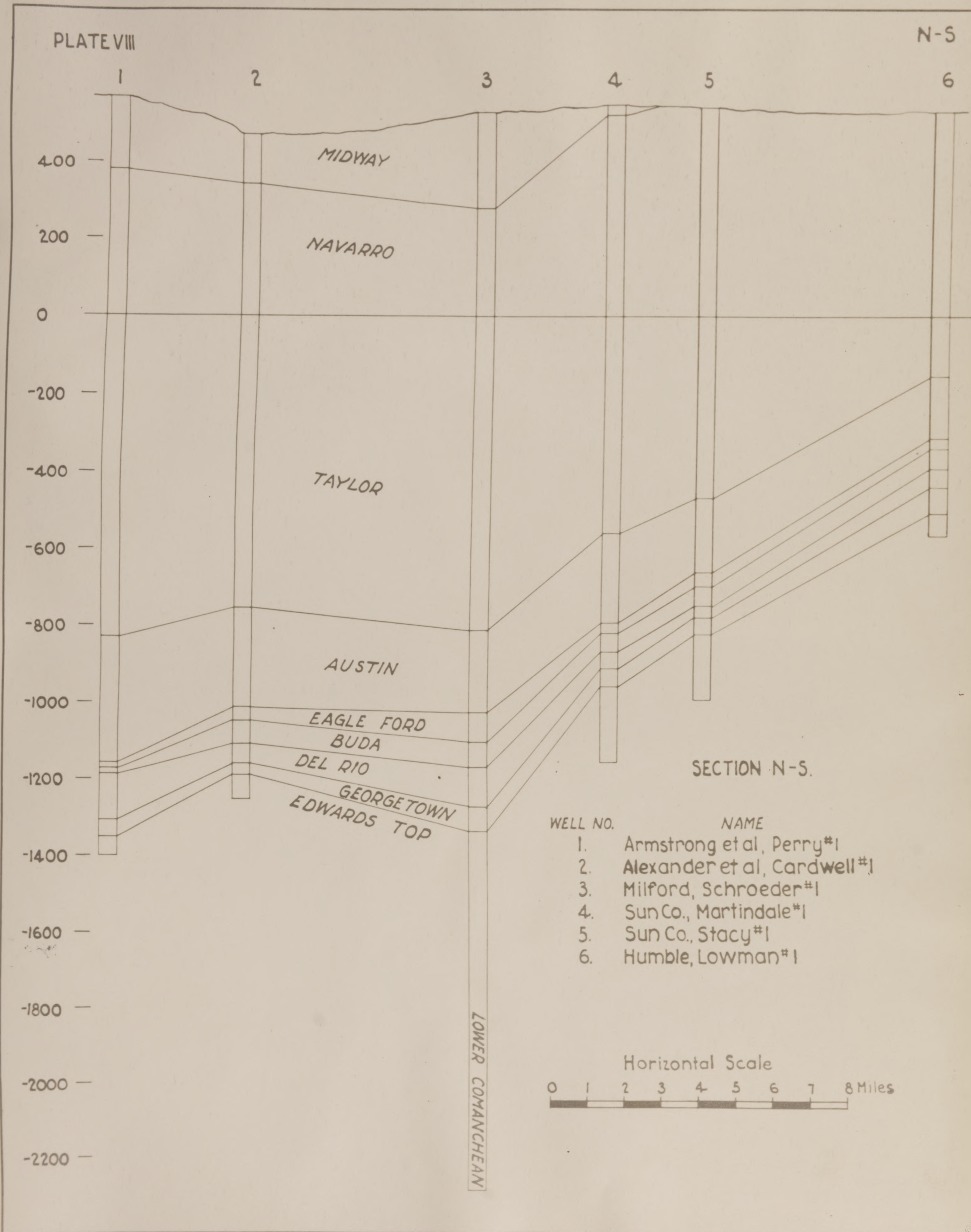


PLATE VIII
N-S
1
2
3
4
5
6
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
MIDWAY
NAVARRO
TAYLOR
AUSTIN
EAGLE FORD
BUDA
DEL RIO
GEORGETOWN
EDWARDS TOP
LOWER COMANCHEAN
SECTION N-S.
WELL NO.
NAME
1. Armstrong et al, Perry #1
2. Alexander et al, Cardwell #1
3. Milford, Schroeder #1
4. Sun Co., Martindale #1
5. Sun Co., Stacy #1
6. Humble, Lowman #1
Horizontal Scale
0 1 2 3 4 5 6 7 8 Miles